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In The Matter Of a European  
Patent (UK)

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fully conversant with the English and Korean languages, hereby certify that to the best of my knowledge and belief the following is a true translation into the English language, which has been made/compared by me and for which I accept responsibility, of the specification of the European Patent No.:  
Korea Application No.: 2002-72188 and 2002-73866

*Goldjin*  
Signed this 16<sup>th</sup> day of January 2006

## **[SPECIFICATION]**

### **[TITLE OF THE INVENTION]**

#### **CATHODE RAY TUBE**

### **[BRIEF DESCRIPTION OF THE DRAWINGS]**

Fig. 1 is a diagram explaining a structure of a known color cathode ray tube.

Fig. 2 is a diagram explaining a structure of a panel for the known cathode ray tube.

Fig. 3 is a diagram explaining a structure of an effective surface portion of the panel for the known cathode ray tube.

Fig. 4 is a diagram explaining an effective surface portion of the panel for the cathode ray tube according to the present invention.

Fig. 5 is a diagram explaining the effective surface portion of the panel for the cathode ray tube according to the present invention.

### **<DESCRIPTION OF THE SYMBOLS IN MAIN PORTIONS OF THE DRAWINGS>**

1: Spring	2: Funnel
3: Funnel	4: Stud pin
5: Electron beam	6: Electron beam
7: Fluorescent screen	8: Shadow mask
9: Mask frame	10: Reinforcing band
11: Inner shield	13: Deflection yoke
14: Effective surface portion	15: Long side portion
16: Short side portion	17: Diagonal portion
18: Skirt portion	

### **[DETAILED DESCRIPTION OF THE PRESENT INVENTION]**

**[OBJECT OF THE PRESENT INVENTION]**

**[FIELD OF THE INVENTION AND DESCRIPTION OF THE RELATED ART]**

The present invention relates to a cathode ray tube, and more particularly, to a cathode ray tube of which outside surface is substantially flat and of which inside surface is curved at a predetermined curvature.

Fig. 1 is a diagram explaining the structure of an already-known color cathode ray tube.

Referring to Fig. 1, the conventional color cathode ray tube includes a front side glass panel 3, and a rear side glass funnel 2 welded to the panel 3. The panel 3 and the funnel 2 are welded to each other in a manner that their inside is vacuum, thereby forming a vacuum tube.

A fluorescent screen 7 is formed on the inside surface of the panel 3, and an electron gun 6 is mounted on a neck portion of the funnel 2 being opposed to the fluorescent screen 13.

A shadow mask 8 with a color selecting function is situated between the fluorescent screen 7 and the electron gun 6, maintaining a predetermined distance from the fluorescent screen 7, and the shadow mask 8 is supported by a mask frame 9. Also, the mask frame 9, being elastically supported by a mask spring 1, is connected to a stud pin 4 to be supported to the panel 3.

The mask frame 9 is jointed with an inner shield 11 made of magnetic material to reduce the movement of an electron beam 5 due to external magnetic field when the cathode ray tube is in the middle of operation.

On the other hand, a deflection yoke 13 for deflecting the electron beam 5 emitted from the electron gun 6 is mounted into a neck portion of the funnel 2.

Also, a reinforcing band 10 is included in order to reinforce the front surface glass under the influence of vacuum state of the inside the tube.

To explain the operation of thusly constructed color cathode ray tube, the electro

n beam 5 emitted from the electron gun 6 is deflected vertically and horizontally by the deflection yoke 13, and the deflected electron beam 5 passes through a beam passing hole on the shadow mask 8 and strikes the fluorescent screen 7 on the front, consequently displaying a desired color image.

Particularly, the inner shield 11 shields the magnetic field from the rear side of the cathode ray tube.

Whether the panel 3 is explosion proof or has substantially good visibility is heavily dependent on how its inside and outside surface curvatures are formed. Especially, the inside surface curvature has a great impact on the sense of flatness of the screen and the presence of distortion of the image.

Further, transmission rate of the panel 3 plays a very important role for realizing a high quality cathode ray tube because the uniform brightness and high contrast are entirely dependent upon the transmission rate of the panel 3.

Generally, the inside surface curvature of the panel can be expressed by a ratio (or Wedge) of a thickness of a diagonal end to a thickness at a central portion of the panel. Compared with a cathode ray tube with a curved outside surface, of which wedge is about 1.30, a cathode ray tube having a substantially flat panel has a higher than 2.2 of wedge, meaning that the peripheral portion of this panel, particularly the thickness of a diagonal end, is extremely thick.

Fig. 2 is a diagram explaining the structure of a panel for the known cathode ray tube.

As illustrated in Fig. 2, the panel 3 in approximately rectangular shape is formed of an effective surface portion 14 where the fluorescent screen is formed, a long side portion 15, a short side portion 16, and a diagonal portion 17. A skirt portion 18 in curved shape is formed extending away from the edge of the effective surface portion 14 to a rear side of the tube axis direction.

Fig. 3 is a diagram explaining the structure of the effective surface portion of the panel in the known cathode ray tube.

Referring to Fig. 3, the substantially flat panel, when the outside effective surface 14 is seen with the naked eye, has an outside surface curvature radius that one might consider the outside surface is almost flat while the inside surface of the panel has a generally accepted curvature.

More specifically, the inside surface curvature can be largely divided into three types: a vertical curvature radius ( $R_v$ ) in the vertical direction (V), a horizontal curvature radius ( $R_h$ ) in the horizontal direction (H), and a diagonal curvature radius ( $R_d$ ) in the diagonal direction.

In general, these curvature radii are in a relation of  $R_d > R_h > R_v$ .

That is, the diagonal curvature radius ( $R_d$ ) is greater than the horizontal curvature radius ( $R_h$ ), and the horizontal curvature radius ( $R_h$ ) is greater than the vertical curvature radius ( $R_v$ ).

Typically, the wedge, i.e. the ratio of the thickness of a diagonal end to the thickness at a central portion of the panel (CFT), ( $T_d/CFT$ ), ranges 2.0 to 2.3. As the wedge ( $T_d/CFT$ ) gets closer to 1, the sense of flatness of the screen and manufacturing advantages of the panel are improved. However, it was also discovered that the shadow mask at a predetermined distance from the inside surface of the panel 3 could be easily deformed by an external shock.

To obviate such problem, the wedge ( $T_d/CFT$ ) is usually set higher than 2.0.

However, increasing the wedge means increasing the thickness at the central portion of the panel 3 (CFT) in contrast to the thickness of the diagonal end ( $T_d$ ). In doing so, the panel 3 often broke down during a thermal process out of the manufacturing procedure, and the screen of flatness of the image was also deteriorated as the inside surface curvature radius of the panel was decreased due to the high wedge.

Moreover, if the thickness of the peripheral portion of the panel 3 is increased, its transmission rate is noticeably reduced as well, extremely lowering the uniformity of brightness.

For instance, suppose that the wedge of the panel used in a 27-inch cathode ray

tube is about 2.2. Then the transmission rate at the central portion of the panel is 51% while the transmission rate at the peripheral portion of the panel is about 25%, less than 1/2 (0.5) of the transmission rate at the central portion of the panel. This resultantly breaks down the uniformity of brightness, making the cathode ray tube totally useless.

Therefore, the minimum ratio of the transmission rate has to be more than 0.6% so as to implement the basic performance of the cathode ray tube.

In order to improve the darkness of the screen due to the degradation of the transmission rate at the peripheral portion of the panel 3, when 10.16 mm that is a reference thickness of the transmission rate scale of the panel 3 is centered on, the transmission rate at the central portion increased up to 80%. By using the panel 3 with high transmission rate of about 80%, the indoor illuminance or solar light is easily transmitted through the panel 3. Therefore, the difference (contrast) between the bright portion and the dark portion of the screen is extremely lowered, thus degrading the quality of the picture.

Introduced to overcome the above drawback is putting a coating or film on the panel. However, the method was not found very favorable because it required an extra process and cost

#### **[TECHNICAL OBJECT OF THE INVENTION]**

An object of the present invention is to provide a cathode ray tube capable of solving the reduction of the contrast by using a panel with a transmission rate of below 80% at the central portion of the panel, and preventing the distortion of the image by making the wedge in the range of below 2.0.

Also, another object of the present invention is to a cathode ray tube capable of improving the structure of the panel such that the mechanical strength can be maintained even when the wedge is below 2.0.

#### **[CONSTITUTION AND OPERATION OF THE INVENTION]**

To attain the above objects, a

The following detailed description will present a cathode ray tube according to a preferred embodiment of the invention in reference to the accompanying drawings.

Figs. 4 and 5 are diagrams explaining the effective surface portion of the panel for the cathode ray tube according to the present invention.

To gain high contrast, the transmission rate at the central portion of the effective portion of the panel was lowered from the conventional level, i.e. 80%, to 45-75% while maintaining the brightness of images, and to prevent the brightness at the peripheral portion from being too dark after lowering the transmission rate at the central portion of the panel, the ratio of the transmission rate at the peripheral portion to the transmission rate at the central portion should be at least 60% and more and the wedge was maintained below 2.0.

When the wedge is below 2.0, the shadow mask loses its mechanical strength and shock resistance of the panel is somewhat lowered. To preserve the strength of the shadow mask and panel at a low wedge, it is necessary to get an optimized inside surface curvature radius.

In general, the inside surface curvature radii of the panel satisfy a relation of diagonal curvature radius ( $R_d$ ) > horizontal curvature radius ( $R_h$ ) > vertical curvature radius ( $R_v$ ). The problem with such relation was that it only set a limitation on the strength of the shadow mask.

For this reason, the present invention restructured the inside of the panel, such as, horizontal curvature radius ( $R_h$ ) > diagonal curvature radius ( $R_d$ ) > vertical curvature radius ( $R_v$ ).

Moreover, the panel of the present invention is similar to the conventional one in a sense that the outside surface curvature radius of the panel was appropriately set enough to make the viewer believe the screen is flat. As the outside surface curvature radius of the panel increases, the sense of flatness the viewer feels is improved as well. However, the viewer will soon feel no difference when the outside surface curvature radius

s of the panel reaches a certain level where the sense of flatness is saturated.

On the other hand, in case the outside surface curvature radius is increased, the panel is left with more tension. Hence, there may have to be a certain limitation on the flatness of the panel to keep it minimum.

Suppose that outside surface flatness ratio of the effective surface of the panel is F, outside surface diagonal curvature radius of the panel is Ro, and diagonal length of the effective surface of the panel is Sd. Then, the outside surface flatness ratio

$$F = \frac{Ro}{Sd \times 1.767}$$

Preferably, the flatness ratio (F) is greater than 17 in considerations with the sense of flatness and the tension of the panel.

For instance, the outside surface diagonal curvature radius (Ro) of the panel for a 32-inch cathode ray tube whose flatness ratio (F) is 21 can be obtained from the above formula, i.e.  $Sd \times 1.767 \times 21 = 680\text{mm} \times 1.767 \times 21 = 25232\text{mm}$ .

In addition, the central thickness of the effective surface of the panel (CFT), the thickness of the diagonal end of the panel (Td), the thickness of the horizontal axis end of the panel (Th), and the thickness of the vertical axis end of the panel (Tv) are in a specific relation to one another. For example, the wedge ( $Td/CFT$ ) should be greater than 1.4 and smaller than 2.0 so as to reinforce the strength of the shadow mask.

If the wedge ( $Td/CFT$ ) is smaller than 1.4, the shadow mask is not strong enough, and if it is greater than 2.0, the transmission rate at the peripheral portion of the panel becomes too low to maintain the uniform brightness.

Therefore, the ratio of the thickness of the diagonal end of the panel (Td) to the central thickness of the panel (CFT) should satisfy a condition of  $1.4 < Td/CFT < 2.2$ .

For the sake of maintaining the uniformity of brightness, the ratio is preferably in a condition of  $1.4 < Td/CFT < 2.0$ .

More preferably, the ratio of the thickness of the vertical axis end of the panel (Tv) to the thickness of the diagonal end of the panel (Td) is preferably in a condition of  $0.9 < Tv/Td < 1.00$ , taking the uniform brightness for the screen more seriously.

Table 3 below illustrates an embodiment applying appropriate values to the panel of the 29-inch cathode ray tube according to the present invention.

[Table 1]

	Rv	Rh	Rd	Rh/Rd	Rv/Rd
Embodiment	1809mm	5676mm	4616mm	1.23	0.36

As shown in Table 1, the inside surface curvature radii of the effective surface of the panel according to the present invention are in the relation of horizontal curvature radius (Rh) > diagonal curvature radius (Rd) > vertical curvature radius (Rv).

Following the above condition, it is possible to make the shadow mask have a larger diagonal curvature than the conventional one (diagonal curvature radius is smaller than horizontal curvature radius) and at the same time, reinforce the strength of the shadow mask.

In the ratio of each curvature radius, a ratio of the curvature radius (Rd) of the diagonal inside surface to the curvature radius (Rh) is 1.23 and the vertical curvature radius (Rv) with respect to the curvature radius (Rd) of diagonal inside surface is 0.36.

That the ratio (Rh/Rd) of the curvature radius (Rh) to the curvature radius (Rd) of the diagonal inside surface is greater than 1.0 and less than 1.3 is preferable considering the panel and the mechanical strength of the shadow mask.

When the ratio (Rh/Rd) is greater than 1.3, the thickness (Th) at the end of the panel horizontal axis gets thinner, thereby increasing the tension stress.

Also, that the ratio (Rv/Rd) of the curvature radius (Rd) of the diagonal inside surface to the curvature radius (Rv) of the vertical inside surface is greater than 0.3 and less than 0.9 is preferable considering the panel and the mechanical strength of the shadow mask.

That is, it is preferable to meet the conditions of  $1.0 < Rh/Rd < 1.3$  and  $0.3 < Rv/Rd < 0.9$ .

Like this, the structure of the curvature radius of the panel is modified and thus th

the thickness of the panel is modified, resulting in table 2 below. Table 2 shows the test result of the characteristics of the cathode ray tube and the shadow mask.

[Table 2]

	CFT	Th	Tv	Td	Tv/Td	Td/CFT	Drop Strength	Howling
Embodiment	12.5 mm	18.2 mm	23.5 mm	23.8 mm	0.99	1.90	21.0G	136Hz
Related art	12.5 mm	21.0 mm	25.2 mm	27.6 mm	0.91	2.21	21.5G	118Hz
Difference	0 m	-2.80 mm	-1.68 mm	-3.80 mm	0.08	-0.31	-0.5G	+18Hz
Effect		Thickness is reduced			Improved	Reduced by 0.31	Constant	Improved

As Table 2 shows, the thickness of the diagonal end of the panel (Td) was reduced by 3.8mm, the thickness of the horizontal axis end of the panel (Th) was reduced by 2.8mm, and the thickness of the vertical axis end of the panel (Tv) was reduced by 1.68 mm. Meanwhile, the ratio of the thickness of the vertical axis end of the panel (Tv) to the thickness of the diagonal end of the panel (Td) was increased by 0.08, the drop strength of the cathode ray tube showed little change, and the wedge was reduced by 0.31 being smaller than 2.0.

Also, primary resonance frequency determining the howling characteristic of the shadow mask is increased by 18Hz and thus it is possible to secure more excellent characteristic than the related art.

Table 3 shows results of transmission rates and wedges of the panel for the cathode ray tube according to the present invention.

[Table 3]

		Thickness	Transmiss	Coating Tr	Final Tran	Ratio of Tr	Wedge

		of Panel (m m)	ion rate ( %)	ansmissio n rate(%)	smission r ate(%)	ansmissio n rates (%) )	
Embodim ent	Central portion	12.5mm	51.2%	Not applic ed.	51.2%	59.4%	1.9
	Peripher al portio n	23.8mm	30.4%	Not applic ed.	30.4%		
Comparati ve Exampl e	Central portion	12.5mm	77.6%	68%	52.8%	82.3%	2.206
	Peripher al portio n	27.6mm	63.9%	68%	43.5%		
Difference	Central portion	0.0mm	-26.5%	-26.5%		-22.9%	-0.306
	Peripher al portio n	-3.8mm	-33.5%	-33.5%			

As shown in Table 3, the transmission rate of the panel according to the present invention was not much different from that of the conventional panel of which outside sur

face was coated, except that the peripheral thickness of the panel according to the present invention was reduced, and the ratio of the peripheral transmission rate to the central transmission rate was 59.4%, which is almost 60%. This proves that the cathode ray tube to which the present invention is applied is sufficiently competent to carry out basic performances required of the cathode ray tube.

Also, the wedge of the panel according to the present invention was 1.9, which is 0.306 smaller than the wedge of the conventional panel. This ensures the uniform brightness of the screen and the sense of flatness.

Fig. 6 is a diagram explaining the length of skirt portion of the panel for the cathode ray tube according to the present invention.

As depicted in Fig. 6, in case of the panel having the substantially flat outside surface, the thickness of the skirt portion is relatively thinner than the edge of the effective surface. In this type of panel, given the inside the panel forms a vacuum, the panel is often under tension due to the vacuum.

Particularly, the tension is intensively applied to the skirt portion that is relatively thinner than the edge of the effective surface, thereby weakening the structural strength of the skirt portion even more.

This phenomenon becomes intensified as the length of the skirt portion (OAH) is reduced.

Therefore, in order to minimize the tension, it is needed to control the length of the skirt portion (OAH) of the panel at an appropriate level. Preferably, the ratio of the length of the skirt portion of the panel, OAH, to the diagonal length of the effective surface of the panel, Sd, satisfies a condition of  $0.13 < OAH/Sd < 0.17$ .

When the ratio of the length of the skirt portion of the panel, OAH, to the diagonal length of the effective surface of the panel, Sd, is smaller than 0.146, tension of the skirt portion will be concentrated on the contact surface of the panel and the funnel up to 10Mpa and more, possibly exceeding the tensile stress limit of a vacuum vessel (not larger than 10Mpa) and giving rise to a safety problem.

On the other hand, when the ratio of the length of the skirt portion of the panel, OAH, to the diagonal length of the effective surface of the panel, Sd, is greater than 0.17, although the tension would be sufficiently reduced, the weight of the panel would be increased and the total length of the cathode ray tube would be increased.

For instance, in case that OAH/Sd is 0.146, the skirt portion in a 29-inch cathode ray tube was under tension as big as 9.7Mpa. Also, when OAH/Sd is 0.170, 8.1Mpa of tension was produced.

In short, it is desirable to keep the ratio of the length of the skirt portion of the panel, OAH, to the diagonal length of the effective surface of the panel, Sd, in the range of  $0.146 < OAH/Sd < 0.17$ , so as to minimize tension on the panel and reduce total weight and length of the cathode ray tube.

#### **[EFFECT OF THE INVENTION]**

In conclusion, the cathode ray tube according to the present invention can be advantageously used in that it has improved contrast simply by lowering the transmission rate of the panel and reduced manufacturing cost without requiring a separate coating process on the panel.

Also, manufacturers can improve the sense of flatness of the screen and protect the cathode ray tube from damages by lowering the wedge. Since the panel is thinner, the total weight of the cathode ray tube is also reduced.

The shadow mask now has an improved howling characteristic.

Lastly, the tension on the panel can be minimized while reducing the total length and weight of the cathode ray tube.